REPLACEMENT OF OPTICAL FIBER AND INFRASTRUCTURE IN THE METRO MOVER LOOPS AND OMNI / BRICKELL EXTENSIONS

MIAMI-DADE TRANSIT
METRO MOVER FIBER INSTALLATION
PROJECT SCOPE

Prepared by
Colin Armorer
Field Engineering
Miami-Dade Transit
December 01, 2009

TABLE OF CONTENTS

Statement of Work

1. Introduction/Background

Metro Mover is a free automated people-mover system that serves downtown Miami from Omni to Brickell and connects with Metro Rail at Government Center and Brickell stations. There are 20 conveniently-located wheelchair-accessible Metro Mover stations, one about every two blocks.

Metro Mover links many of downtown Miami's major office buildings, hotels, and retail centers, the Stephen P. Clark Government Center, the Cultural Plaza (Miami Art Museum, Historical Museum, Main Library), and the Brickell business district. With Metro Mover cars arriving frequently, getting around downtown is fast, convenient and free.

The MetroMover system bas built in two separate phases:

Phase 1 of the Metro Mover is comprised of downtown inner and outer loops and Phase 2 is comprised of the Omni and Brickell extensions that connect with the downtown outer loop. For easy travel around downtown Miami, the inner loop can be used. Metro Mover cars serving Brickell and Omni alternate on the outer loop.

The Omni and Brickell legs have six stations each that connect with the outer loop in central downtown. To travel from Omni to Brickell travelers can transfer to a Brickell car at Third Street Station. To travel from Brickell to Omni, they can transfer to an Omni car at College/Bayside Station.

Several critical operational functions that control the performance and safety of the Metro Mover cars are controlled by a Data Transmission System (DTS) that is comprised of 3 separate Programmable Logic Controller (PLC) Systems located at the Stephen Clark Center, and several remote field modules. In the Inner and Outer loops, the PLC communicates with remote Serial Interface Modules and Input/Output control hardware over a copper based transportation network.

In the extensions, the PLC communicates with the Serial Interface Modules and Input/Output control hardware over a Fiber Optic transportation network. The existing fiber is 200 micro-meter multi mode fibers that have significantly degraded in optical performance. A result of those degradations is reduced the reliability and robustness of the Optical transportation network.

In both the Omni and Brickell extension stations, the remote modules also communicate using 200 micro-meter multi mode fiber. The current architecture does not provide any optical protection.

2. Objectives

The Project objectives encompass the following tasks:

- Installation of 9 micron single-mode fiber optic cable throughout the Metro Mover system to enable the following two sub-tasks to be realized:
  - Replacement of existing multi-mode fiber optic cable used in the Phase II Metro Mover extensions with 9 micron single mode fiber.
  - Replacement of copper infrastructure in the inner and outer loops with 9 micron single-mode Fiber Optic Cable.
- Replacement of Phase I equipment used to control the Power Distribution System and carry Data Transmission System information between Central Control and the Train Control rooms on the Metro Mover System.
- Replacement of Phase II equipment used to control the Power Distribution System and carry Data Transmission System information between Central Control and the Train Control rooms on the Metro Mover System.
- Installation of 9 micron single-mode fiber between each Train Control room and the station platform level
- Introduction of a Local Area Network presence in all Train Control rooms
- Introduction of 802.11 g/n compliant Wireless presence at the train platform levels.
- Provide Fiber Optic Cable infrastructure to support improved operability, reliability and availability of the following systems:
  - Fire System control and communications
  - Voice communications
  - Public Address System
  - Closed Circuit TV – Safety and Security
  - Low Speed Serial data
  - Other Services that may be added in the future.

3. Scope

The scope of the project titled REPLACEMENT OF OPTICAL FIBER AND INFRASTRUCTURE IN THE METRO MOVER LOOPS AND OMNI / BRICKELL EXTENSIONS, hereafter referred to as The Metro Mover Fiber Project shall encompass the following components:

4. Fiber Optic Cable Installation:

Installation of new Single Mode Fiber Optic Cable to service all Metro Mover Stations, the Metro Mover Maintenance Facility and Metro Mover equipment located on the fourth floor of the Stephen P. Clark Center located at:
111 NW First Street
Miami, Florida 33128

A total of 24 locations comprised of 22 Metro Mover stations, the Metro Mover Maintenance Facility and the Stephen Clark Center shall have Fiber Optic Cable installed to meet the requirements as set forth in section 6.

5. Programmable Logic Controller Replacement:

The 6 existing Programmable Logic Controllers (with redundancy) shall be replaced with 2 Programmable Logic Controllers (with redundancy). The new PLCs shall control the entire Metro Mover infrastructure currently controlled by the existing six controllers. The new controllers shall utilize the newly installed fiber optic cable in a ring configuration that shall ensure recoverability, path redundancy and optical protection.

6. Ethernet Network:

An Ethernet Presence shall be established at all 24 locations (Note that this is independent of the Ethernet network to be provided in section 3.3) The installed switches shall support Power-Over-Ethernet.

7. Task Identification

The technical Specifications address all installation and testing tasks that are required to be performed.

8. Time and Deliverables

This project is time sensitive. The ARRA grant expires in May of 2012. The two high-level milestones that need to be met are:

- Advertisement of RFP on or before August 31, 2010
- Project completion/closure on or before December 2011 (to provide an adequate time for the submission of all final invoices to Transit and the posting of all invoices to satisfy ARRA requirements)

9. Project Management Contact Information

Project Name:	Metro Mover Fiber and Infrastructure Replacement
Contact Name:	Colin Armorer
Contact Information:	305-637-3852

10. Budget/Funding

The project is being fully funded through the American Recovery and Reinvestment Act of 2009 (ARRA) and is subject to all the requirements associated with ARRA grants including BUY AMERICA requirements.

PLEASE GO TO THE NEXT PAGE

11. General Requirements

11.1 Operating Voltage and Environmental Requirements:

All equipment shall operate, except where noted, within the following voltages and temperature ranges:

11.2 Operating Voltage:

All equipment (except where noted) shall be capable of operating with a voltage supply input within the range of 90 VAC to 240 VAC.

11.3 Operating Temperature

All equipment (except where noted) shall be capable of operating within a temperature range of 0 degrees Celsius to 60 degrees Celsius.

11.4 Physical Protection and Security

All in-station equipment shall be protected in a single equipment cabinet that meets the following specifications:

- The enclosure type shall be a Double Swing enclosure with Plexiglas Door. The height of the enclosure shall be adequate to house all fiber, controller, networking equipment with adequate space to add 2 additional 2U pieces of equipment.
- The enclosure shall supply power to the housed equipment.
- The enclosure shall include a fan to provide adequate air flow within, and air exchange into the cabinet.

11.5 Recognized National Testing Facility Requirements

All electronic equipment shall be UL listed for its intended use.

12. Fiber Installation requirements:

All installed Fiber Optic Cable shall meet or exceed all applicable NEC requirements for OSP Fiber Optic Cable. Refer to the section entitled **NFPA 70 Requirements** for additional information. Fiber Optic Cable shall be UL Listed for its intended use.

- Fiber Optic Cable shall be installed as continuous runs between contiguous indoor termination points. No splicing of cable strands, regardless of available methodologies, shall be used.
- In building terminations:
    - All buffer strands shall be terminated on an appropriate patch panel that is protected within an enclosure designed to protect the fiber terminations from casual access. The enclosure will house additional equipment.
    - Termination connections and patch panels shall be protected by equipment enclosures.
    - All Fiber terminations shall be of type LC.
    - In-room fiber shall be protected by metallic conduit between the room entry and enclosure entry points.
    - All cable sheathing protection shall remain intact when not protected by an enclosure.
- Optical Cable shall be protected by fiberglass reinforced epoxy conduit for all vertical drops and building entry paths where existing entry conduit is inaccessible or unusable.
- Existing or new entry conduits/innerduct shall be sealed to prevent water incursion and retention within the conduit/innerduct.
- Identify cable entry and exit paths to/from the fourth floor in the Stephen P. Clark Building.
- The installation of the Fiber Optic Cable at all termination locations shall adhere to a standardized cabling architecture that utilizes Structured Cabling in conformance with EIA/TIA 568 B.3.
- Install 12 strand single mode 9 micron fiber optic cable between Train Control room and vehicle platform.
- All fiber between a Train Control Room and the Station platform level shall be protected by Fiberglass Reinforced Epoxy conduit.
- All manufacturer's installation and long-term mechanical specifications and requirements shall be adhered to.
- All installed Fiber Optic cable shall be labeled at points of termination to identify the contiguous end points. The vendor shall propose a labeling standard for approval by the Engineer.
- Arrange for alternate building entrances for each of the diverse runs.
- There shall be no structural or other modifications or construction work to the SPCC building or any other building beyond that required to route the fiber optic cables into the building.

13. Installation Options

The Contractor shall provide pricing based on each of the two alternative installation options:

13.1 Option 1

Install self support (messenger wire included) Fiber Optic Cable with beam clamps affixed to the Mover guideway support structure.

13.2 Option 2

Install Fiber Optic Cable in protective innerduct in existing cable trays.

14. Standards compliance for OSP Single Mode Fiber Cable

All installed OSP Fiber Optic Cable shall meet the following standards:

- ANSI/TIA/EIA-492CAAB-2000 (R2005) requirements and specifications for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak.
- IEC - 60793-2-50 Type B1.3
- ANSI/ICEA - S-83-596
- Telcordia GR-20-CORE - Generic Requirements for Optical Fiber and Optical Fiber Cable
- ICEA S-87-640-2006 - Standard for Optical Fiber Outside Plant Communications Cable
- ISO/IEC - 24702: OS2
- RoHS-compliant

15. Specifications:

- Single Mode Core / Cladding - 9/125 µm
- **Cable for Option 1**: - Loose Tube Double Jacket Single Armor Self Support – 72 fiber – 9 micron – Zero Water Peak
- **Cable for Option 2**: - Loose Tube Triple Jacket Double Armor – 72 fiber – 9 micron – Zero Water Peak
- Fiber Optic Cable between the Train Control Room and the platform area - Loose Tube Single Jacket Single Armor – 12 fiber – 9 micron – Zero Water peak.
- All OSP Fiber Optic shall meet or exceed the Specifications as outlined in Table 1 on the following page.

Numbers indicated in the column labeled 'Value' represent the minimum acceptable values for the Fiber Optic Cables' optical and mechanical performances.

Parameter	Standard	Measurement Units	Measured at Optical Wavelength	**Value**
Maximum Attenuation	ANSI/TIA-455-78-B-2002	dB/km	1310	0.35
			1383	0.35
			1490	0.25
			1550	0.25
			1625	0.25
Nominal Group Refractive Index	–	–	1383	1.467
	–	–	1550	1.468
Maximum Individual Fiber Polarization Mode Dispersion	ANSI/TIA/EIA-455-113-96	ps $km^{-1/2}$	–	0.2
Cable Cutoff Wavelength	ANSI/TIA-455-80-C-2003	nm	–	1260
Zero Chromatic Dispersion Wavelength	ANSI/TIA-455-175-B-2003	nm		1300 – 1324
Typical Chromatic Dispersion Slope	ANSI/TIA-455-175-B-2003	ps/nm^2- km		0.087
Proof Strength	TIA/EIA-455-31	kpsi	On-Line	100
		Gpa	On-Line	0.69
Mode Field Diameter	ANSI/TIA-455-191-B-2003	µm	1310	8.8 to 9.6
			1550	9.9 to 10.9
Maximum Macro Bend Attenuation – 100 turns on 50 mm Mandrel	ANSI/TIA-455-62-B-2003	dB	1310	0.05
Cladding Diameter	ANSI/TIA-455-176-A-2003	µm		125.0 ± 0.9
Coating Diameter	ANSI/TIA-455-176-A-2003	µm		250 ± 10
Maximum Core/Clad Concentricity Error	ANSI/TIA-455-176-A-2003	µm		0.5
Maximum Core/Clad Non-circularity	ANSI/TIA-455-176-A-2003	%		1
Maximum Coating/Cladding Concentricity Error	ANSI/TIA-455-176-A-2003	µm		12

Table 1 – Minimum Requirements for installed OSP Fiber Optic Cable.

15.1 ANSI/TIA Standards Details

ANSI/TIA-455-78-B-2002 - FOTP-78 - IEC 60793-1-40 Optical Fibers Part 1-40: Measurement Methods and Text Procedures – Attenuation

ANSI/TIA-455-62-B-2003 - FOTP-62 - IEC-60793-1-47 Optical Fibers Part 1-47: Measurement Methods and Test Procedures - Macrobending

ANSI/TIA-455-191-B-2003 - FOTP-191 - IEC 60793-1-45 Optical Fibers - Part 1-45: Measurement Methods and Test Procedures - Mode Field Diameter

ANSI/TIA-455-176-A-2003 - FOTP-176 - IEC 60793-1-20 Optical Fibers Part 1-20: Measurement Methods and Test Procedures - Fiber Geometry

ANSI/TIA-455-175-B-2003 - FOTP-175 - IEC 60793-1-42 Optical Fibers Part 1-42: Measurement Methods and Test Procedures - Chromatic Dispersion.

ANSI/TIA/EIA-455-113-96 (R2001) - FOTP-113 - Polarization-Mode Dispersion Measurement of Single-Mode Optical Fibers by the Fixed Analyzer Method.

15.2 Option 1 - Cable Sag

Adequate cable support shall be provided such that a maximum cable sag of three (3) inches is not exceeded while ensuring that the following criteria do not exceed 75 percent of cable manufactures' recommended values at an ambient temperature of :40^{o}F:

- Maximum Tensile load without wind loading.
- Maximum Tensile load plus maximum wind loading.
- Maximum wind loading shall be defined to occur at sustained wind speeds in excess of 154 Miles per hour (equivalent to category 5 wind speeds as defined by the Saffir–Simpson Hurricane Scale).

PLEASE GO TO THE NEXT PAGE

15.3 Installed Fiber Characterization tests:

All installed OSP fiber shall meet or exceed the following Fiber Characterization standards with regards to supporting an OC-48 DWDM or better bandwidth service.

- **Optical Return Loss (ORL)**
  1550nm wavelength, from both fiber ends (bi-directional test)
- **OTDR**
  1550nm & 1625nm wavelengths, bi-directionally averaged
- **Power Meter and Light Source (LTS)**
  1550nm & 1625nm wavelengths, bi-directionally averaged
- **Polarization Mode Dispersion (PMD)**
  1550nm wavelength, single ended
- **Chromatic Dispersion (CD)**

1520nm to 1630nm at 10nm wavelength increments, single ended

15.4 Industry Standards

The following standards shall be used when performing all post installation Fiber Characterization tests:

- **Power Loss**
  - FOTP-171 / EIA-455-171-A - Attenuation by Substitution Measurement for short length Multimode graded index and Single-mode optical fiber cable assemblies.
- **Optical Return Loss (ORL)**
  - FOTP-107 / TIA/EIA-455-107-A Return Loss for Fiber optic components.
- **OTDR**
  - FOTP-59 / TIA/EIA-455-59 - Measurement of Fiber Point discontinuities/defects using an OTDR.
  - FOTP-8 / TIA/EIA-455-8-2000 - Measurement of Connector Loss and Reflectance Using an OTDR.
- **PMD**
  - FOTP124 – TIA-455-124-A - Polarization-Mode Dispersion Measurement for Single-mode Optical Fibers by Interferometry Method.
- **Chromatic Dispersion**
  - FOTP-175 / TIA-455-175-B-2003 - Measurement Methods and Test Procedures - Chromatic Dispersion.

15.5 Post Installation Test Results

- All installed fiber shall meet or exceed manufacturer's specifications for Fiber Characterization for both distance and distance insensitive parameters.

16. Contractor Responsibilities:

- Contractor shall be responsible for identifying all entry/exit paths to/from the fourth floor of the Stephen Clark Building, from the main demarcation point on the fourth floor. These entry/exit paths are located below grade (underground) and may require access via existing access points situated at various locations surrounding the exterior of the SPCC building.
- Contractor shall be responsible for identifying all entry/exit paths to/from ALL Metro Mover Train Control Rooms.
- The contractor shall coordinate all work related liaison with the authorities whose approval is required to permit the project to proceed.
- Systems integration is a key requirement. The contractor must ensure that all equipment shall meet or exceed the requirements of its intended use.
- Provide the lengths of cable installed for each contiguous cable run.
- All applicable and required Permitting approval must me obtained prior to the start of work.
- All final inspections MUST be completed and approved by the jurisdiction having authority, before the project is considered to be closed and completed.
- Contractor safety training and certification shall be required prior to implementation of work on Miami Dade Transit's property. The training and certification shall be performed by Miami-Dade Transit's Training Department in conjunction with the Office of Safety and Security. County issued Contractor Identification badges may also be required. The contractor shall display such identification while on Transit property and shall have in their possession at all times, all associated documentation or identification that shall be issued by the Training Department.
- All other responsibilities not specifically listed but may be required before and during the project to ensure its completion in compliance with the project schedule and within available funding constraints.
- The Contractor shall be responsible for supplying Power at all locations that require Power for the normal operation of installed equipment
- All measurements for distances and dimensions shall be Field Verified.

17. Grounding and Bonding

Grounding of Optical Cable conductors shall adhere to the following standards:

- TIA/EIA-607-1995 (Grounding and Bonding Requirements).
- ALL non-current carrying conductors shall be grounded in conformance to NFPA 70, ARTICLE 770.100.

PLEASE GO TO THE NEXT PAGE

A total of 24 locations shall have 9/125 micron single-mode optical fiber installed.

Architecture/Configuration:
A Ring Architecture shall be used.

72 fiber count cable shall be installed.

Cable Type: Loose Tube

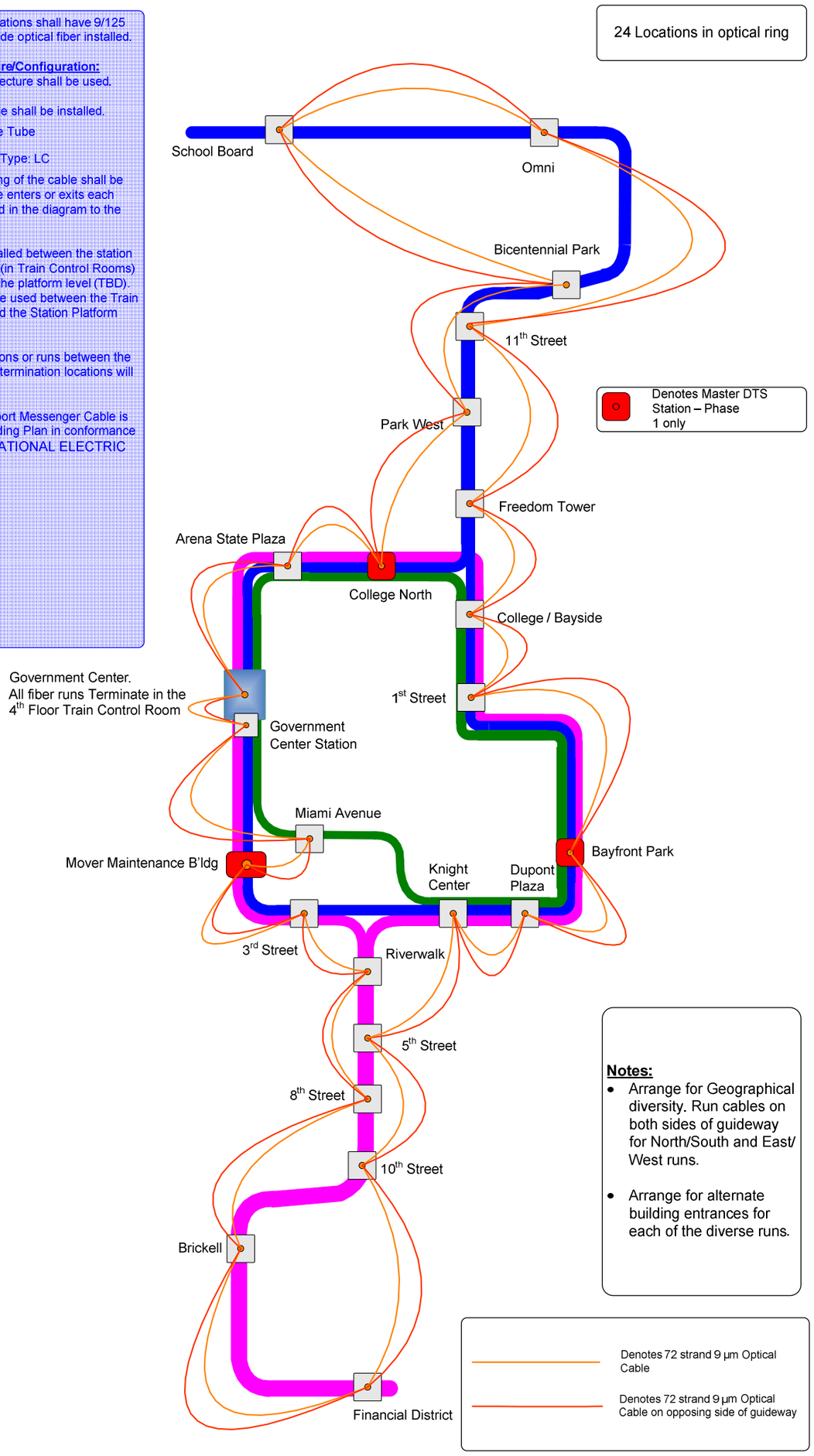
Fiber Termination Type: LC

The physical routing of the cable shall be such that the cable enters or exits each station as indicated in the diagram to the right.

Fiber shall be installed between the station termination points (in Train Control Rooms) and a location on the platform level (TBD). 12 strands shall be used between the Train Control Rooms and the Station Platform locations.

No Aerial installations or runs between the guideway and the termination locations will be permitted.

Grounding of support Messenger Cable is required. – Grounding Plan in conformance with NFPA 70: NATIONAL ELECTRIC CODE



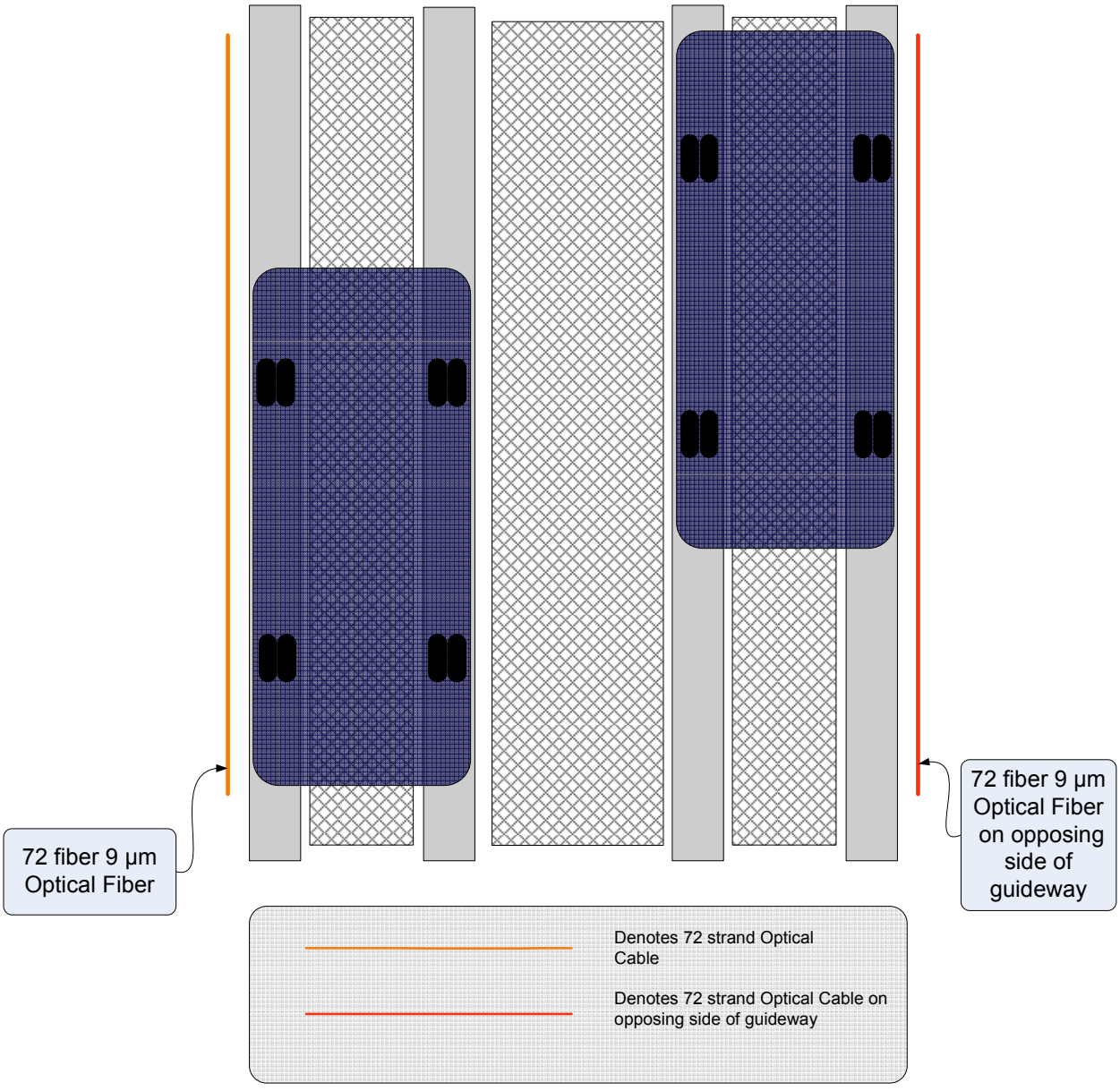


Figure 2 – Diagram showing "geographically diverse" cable routing on Mover Guideway Support

NOT to Scale.
Used for illustrative purposes ONLY.

	From	To	OTDR Distance in Feet	OTDR Distance in Meters
Omni	SPCC/G'vt Center	Freedom Tower	4429	1350.0
	Freedom Tower	Park West	1179	359.4
	Park West	11th Street	1327	404.5
	11th Street	Bicentennial Park	1425	434.3
	Bicentennial Park	Omni	1832	558.4
	Omni	School Board	2620	798.6

	From	To	OTDR Distance in Feet	OTDR Distance in Meters
Brickell	SPCC/G'vt Center	Riverwalk	3933	1198.8
	Riverwalk	5th Street	1266	385.9
	5th Street	8th Street	1246	379.8
	8th Street	10th Street	1352	412.1
	10th Street	Brickell	1655	504.4
	Brickell	Financial District	1698	517.6

	From	To	Inter-Station Linear Distances	Inter-Station Linear Meters
Inner Loop	SPCC/G'vt Center	Arena State Plaza	1209	368.5
	Arena State Plaza	College North	1063	324.0
	College North	College Bayside	1128	343.8
	College Bayside	1st Street	672	204.8
	1st Street	Bayfront park	1689	514.8
	Bayfront park	Dupont Plaza	1036	315.8
	Dupont Plaza	Knight Center	673	205.1
	Knight Center	Miami Avenue	2866	873.6
	Miami Avenue	SPCC	1701	518.5
	Knight Center	3rd Street	-	-
	3rd Street	Maintenance	-	-

	From	To	Inter-Station Linear Distances - ft.	Inter-Station Linear Distances – Meters
Outer Loop	SPCC/G'vt Center	Arena State Plaza	1250	381.0
	Arena State Plaza	College North	1020	310.9
	College North	College Bayside	1153	351.4
	College Bayside	1st Street	672	204.8
	1st Street	Bayfront park	1675	510.5
	Bayfront park	Dupont Plaza	1027	313.0
	Dupont Plaza	Knight Center	673	205.1
	Knight Center	Miami Avenue	-	-
	Maintenance Bld'g	SPCC	1691	515.4
	Knight Center	3rd Street	2390	728.5
	3rd Street	Maintenance	1010	307.8

Table 2: Distances shown are for reference purposes only. Exact cable distances shall be field verified.

18. NFPA 70 Requirements

All OSP Fiber and associated Fiber Optic Cable equipment used for permanent installation shall adhere to the requirements as set forth in the National Electric Code 2008 Handbook: **NFPA 70: NATIONAL ELECTRIC CODE** – International Electrical Code Series, **Article 770** – Optical Fiber Cables and Raceways.

19. Sample Optical Fiber Plant.

OSP Product sheets are presented as samples of the requirements for cable protection only and are not intended to be used as the actual manufacturer or brand to be used. Please refer to the attached Product data Sheets for detailed specifications.

20. Documentation

All Technical, Engineering, Configuration, and Construction documentation shall be submitted to the Miami-Dade Transit Engineer or record prior to the submission of final invoicing.

21. Software

All Software that is required to communicate with, configure, manage, repair or interface with any Electronic communications, control, audio, video, network or any other equipment installed by the vendor, shall be supplied to the Miami-Dade Transit Engineer of record prior to the submission of final invoicing.

22. Suitability for Intended use

All Electronic equipment proposed by the vendor shall have a proven history of use in a Public Transportation Rail environment in the United States that carries a number of Rail Passenger miles per year equal to or greater than the total Miami-Dade Transit's Rail and Metro-Mover yearly Rail Passenger Miles.

23. Interoperability of Electronic equipment

- All installed equipment shall perform in conformance with their individual specifications when installed and interconnected in a production environment.

24. Integration Testing

- The contractor shall submit for approval of the Engineer, a pre-production integrated Test Plan. All installed systems shall be tested to ensure that design specifications are met or exceeded. This test shall be an end-to-end test that tests the system in isolation (not interconnected with or carrying and production data from the existing Metro Mover System).
- All performance criteria shall be logged and presented to the Engineer for review and approval of performance characteristics.

25. Cut over plan

- The contractor shall submit for approval of the Engineer, a detailed cut-over test plan that shall test the integrated in a production environment during off-traffic hours. The plan shall include performance metrics that are derived from the existing system.
- The plan shall include methods for reversion to the existing system in the event of any anomalous or undesired system problems.

26. Manufacturer ISO Registration

- Optical fiber and equipment manufacturers shall be registered to ISO 9001 and ISO 14001.

PLEASE GO TO THE NEXT PAGE

27. Programmable Logic Controller Specifications:

27.1 EXISTING METRO MOVER DATA TRANSMISSION SYSTEM

27.1.1 EXISTING PHASE I Specifications

Location: 4th Floor SPCC -- PC-A -- (Main Rack)
Primary Controller: Westinghouse Numa-Logic PC700B
Redundant Controller: Westinghouse Numa-Logic PC700B
Memory: 4k
Number of Remote Racks: 5
Maximum communication cable run: no more then 10,000 feet
Communication format: Full Duplex, asynchronous, serial
Communication cable type: Belden # 8719 (16 AWG)
Remote Rack Stations: CO, FT, GC, SP & ED

Location: 4th Floor SPCC -- PC-B -- (Main Rack)
Primary Controller: Westinghouse Numa-Logic PC700B
Redundant Controller: Westinghouse Numa-Logic PC700B
Memory: 4k
Number of Remote Racks: 5
Maximum communication cable run: no more then 10,000 feet
Communication format: Full Duplex, asynchronous, serial
Communication cable type: Belden # 8719 (16 AWG)
Remote Rack Stations: WT, DP, MT, BA & FD

27.1.2 EXISTING PHASE II Specifications

Location: 4th Floor SPCC -- PC-C-- (Main Rack)
Primary Controller: Westinghouse HPPC-1700
Redundant Controller: Westinghouse HPPC-1700
Memory: 64k
Number of Remote Racks: 12
Communication format: Fibre Optic Cable.
Communication câble size: 200 Micron
Remote Rack Stations: FR, PW, EL, BP, OM, SB, RW, FS, ET, TN, BR & FD

27.1.3 METRO MOVER DATA TRANSMISSION SYSTEM I/O SUMMARY - PHASE I

PC-A					
Location	No. of Inputs	No. of Outputs	I/O Voltage	TTL Inputs	TTL Outputs
SPCC/4TH FLOOR	48	512	24 VDC	16	0
GOVERNMENT CENTER	96	32	120 VAC	0	0
COLLEGE NORTH /EDCOM	96	32	120 VAC	0	0
FIRST STREET	96	32	120 VAC	0	0
COLLEGE /BAYSIDE	48	16	120 VAC	0	0
STATE PLAZE	48	16	120 VAC	0	0
Total:	432	640		16	0

PC-B					
Location	No. of Inputs	No. of Outputs	I/O Voltage	TTL Inputs	TTL Outputs
SPCC/4TH FLOOR	64	528	24 VDC	16	0
DUPONT PLAZA	96	32	120 VAC	0	0
KNIGHT CENTER/ WORLD TRADE	48	16	120 VAC	0	0
BAYFRONT PARK	48	16	120 VAC	0	0
THIRD STREET/FT. DALLAS	64	32	120 VAC	0	0
MAINTENANCE	144	48	120 VAC	0	0
Total:	464	672		16	0

Phase 1 Totals	896	1312		32	0

27.1.4 METRO MOVER DATA TRANSMISSION SYSTEM I/O SUMMARY - PHASE II

PC-C					
Location	No. of Inputs	No. of Outputs	I/O Voltage	TTL Inputs	TTL Outputs
SPCC/4TH FLOOR	384	944 S_i.O./ 96 S_o.O.	24 VDC	128	96
BRICKELL	96	32	120 VAC	0	0
EIGHT STREET	96	32	120 VAC	0	0
OMNI	96	32	120 VAC	0	0
PARK WEST	96	32	120 VAC	0	0
RIVERWALK	96	32	120 VAC	0	0
SCHOOL BOARD	96	32	120 VAC	0	0
BICENTENIAL PARK	96	32	120 VAC	0	0
ELEVENTH STREET	48	16	120 VAC	0	0
FIFTH STREET	48	16	120 VAC	0	0
FINANCIAL DISTRICT	48	16	120 VAC	0	0
TENTH STREET	48	16	120 VAC	0	0
FREEDOM TOWER	48	32	120 VAC	0	0

Phase 2 Totals	1296	1360		128	96

Note: S_i.O. Denotes Sink Output Module and So.O. denotes Source Output Module.

27.1.5 METRO MOVER DATA TRANSMISSION SYSTEM I/O COUNT – PHASE I

Location: 4th Floor SPCC – PC-A – (Main Rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-708H	24V Input	16	3	48
NL-732H	24V Output	16	32	512
NL-743H	Register Input	16	1	16
Location: 4th Floor SPCC – PC-B – (Main Rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-708H	24V Input	16	4	64
NL-732H	24V Output	16	33	528
NL-743H	Register Input	16	1	16
Location: Government Center – GC – (Remote Rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	6	96
NL-731	110VAC Output	16	2	32
Location: College North/Edcom – (Remote Rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	6	96
NL-731	110VAC Output	16	2	32
Location: First Street – (Remote Rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	6	96
NL-731	110VAC Output	16	2	32
Location: Dupont Plaza – (Remote Rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	6	96
NL-731	110VAC Output	16	2	32
Location: College/Bayside – (Remote rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	3	48
NL-731	110VAC Output	16	1	16
Location: Knight Center/World Trade – (Remote Rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	3	48
NL-731	110VAC Output	16	1	16

Location: Bayfront Park – (Remote Rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	3	48
NL-731	110VAC Output	16	1	16
Location: State Plaza – (Remote rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	3	48
NL-731	110VAC Output	16	1	16
Location: Third Street/Fort Dallas – (Remote Location)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	4	64
NL-731	110VAC Output	16	2	32
Location: Maintenance Building – (Remote Location)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	9	144
NL-731	110VAC Output	16	3	48

PLEASE GO TO THE NEXT PAGE

27.1.6 METRO MOVER DATA TRANSMISSION SYSTEM I/O COUNT – PHASE II

Location: 4th Floor SPCC – PC-C – (Main Rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-708H	24V Input	16	24	384
NL-732H	24V Output	16	59	944
NL-743H	Register Input	16	8	128
NL-753H	Register Output	16	6	96
* NL-735H	24V Output	16	6	96
Location: Brickell – (Remote Rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	6	96
NL-731	110VAC Output	16	2	32
Location: Eight Street – (Remote rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	6	96
NL-731	110VAC Output	16	2	32
Location: Omni – (Remote rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	6	96
NL-731	110VAC Output	16	2	32
Location: Park West – (Remote rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	6	96
NL-731	110VAC Output	16	2	32
Location: RIverwalk – (Remote rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	6	96
NL-731	110VAC Output	16	2	32
Location: School Board – (Remote rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	6	96
NL-731	110VAC Output	16	2	32

Location: Bicentennial Park – (Remote rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	6	96
NL-731	110VAC Output	16	2	32
Location: Eleventh Street – (Remote rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	3	48
NL-731	110VAC Output	16	1	16
Location: Fifth Street – (Remote rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	3	48
NL-731	110VAC Output	16	1	16
Location: Financial District – (Remote rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	3	48
NL-731	110VAC Output	16	1	16
Location: Tenth Street – (Remote rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	3	48
NL-731	110VAC Output	16	1	16
Location: Freedom Tower – (Remote rack)				
I/O Card Model #	Type	No of I/Os per Card	Quantity	Total number of I/Os
NL-710	110VAC Input	16	3	48
NL-731	110VAC Output	16	2	32

Note: The NL-735 Module is a 12 to 125 VDC Source Output Module as opposed to the NL-732 Module that is a 12 to 125 VDC Sink Output Module.

The new PLC shall replace the existing Phase 1 and Phase 2 PLCs and shall be functionally equivalent to the existing Phase 1 and Phase 2 PLCs. At a minimum, it shall be capable of controlling the number and types on inputs and outputs as listed in Sections 27.1.3, 27.1.4, 27.1.5. and 27.1.6.

The new PLC here after referred to as The PLC, shall communicate with the existing Train Control Computers and Station Automatic Train Operation equipment using existing protocols currently in use to communicate with the existing Phase 1 and Phase 2 PLCs.

27.2 PLC Requirements:

27.2.1 Replacement Programmable Logic Controller Requirements

The Main Programmable Logic Controller (PLC) that shall replace the existing 6 (with redundancy) controllers shall be engineered to provide an identical number of Inputs, Outputs and I/O types.

The new PLC shall replace the existing Phase 1 and Phase 2 PLCs and shall be functionally equivalent to the existing Phase 1 and Phase 2 PLCs.. At a minimum, it shall be capable of controlling the number and types on inputs and outputs as listed in Sections 27.1.3 through 27.1.6 inclusive.

Each Station shall be equipped with its individual controller.

27.2.2 Processor Synchronization

The main controllers shall be capable of operating with a main and a hot-standby (event synchronized) processor.

27.2.3 Fail Safe Operation

The new PLC architecture shall support Fail Safe Operation

27.2.4 System Configuration Changes

Changes to the system configuration during operation without impacting functionality

27.2.5 Deployment Architecture

A distributed architecture shall be employed that shall consist of Main Controllers as described in Section 27.2.1 installed on the 4th floor of the SPCC building and remote controllers installed at each of the existing Metro Mover stations and the Metro Mover Maintenance Facility. All inter-controller communications (communications between the Main Controllers and the field/station Controllers) shall use the communications methodology defined in Section 27.2.8.

The Station Controllers shall communicate with existing Station Automatic Train Operation equipment using existing protocols currently in use. The functionality of the method of operation between the Station Controllers and the Automatic Train Control equipment/cabinets shall be maintained. The loss of communications with a Field Controller in the Train Control room shall produce the same operational results in both the Phase 1 and Phase 2 as is currently produced.

27.2.6 Temperature

All equipment shall operate within a temperature range of 0℃ to 70 ℃.

27.2.7 Power Supply requirements

Redundant Power Supplies shall be used.

27.2.8 Distributed Input/Output (I/O) Communications

All Distributed I/O shall use an Ethernet Network that meets the requirements in the section entitled "**Ethernet Network Requirements**" for communications between distributed nodes. Examples of Industrial Ethernet Networks based standard/protocols that may be used include Profinet or Devicenet

27.2.9 Existing interface

The following table defines the existing interfaces between and protocols used with the existing PLCs and the Train Control Computers and ATO cabinets:

Phase	PLC	TCC Communications Protocol	Interface	ATO Cabinet Comm Protocol	Interface
Phase 1	Numa-Logic PC700B	Serial	RS-232	Hard wire - does not use DTS	NA
Phase 2	Westinghouse HPPC-1700	Serial	RS-232	Serial	RS-232

27.2.10 Ethernet Network Requirements:

The following IEEE standards and RFC protocols shall be supported in the distributed I/O environment (reference Section 27.1.14)

- IEEE 802.3 10BASE-T (ISO/IEC 8802.3, Clause 14)
- IEEE 802.3u 100BASE-TX (ISO/IEC 8802-3, Clause 25)
- IEEE 802.Eu Autonegotiation on Twisted Pair (ISO/IEC 8802-3, Clause 28)

- The system shall support and use SNMP v1, v2c and secure SNMP v3
- RFC Support Required:
  - RFC 791(IP)
  - RFC 792(ICMP)
  - RFC 793(TCP)
  - RFC 783(TFTP)
  - RFC 826(ARP)
  - RFC 768 (UDP)
  - RFC 854 (TELNET)
  - RFC 951 (BOOTP)
  - RFC 3376 (IGMPv3)
  - RFC 2236 (IGMPv2)
  - RFC 1112(IGMPv1)
  - RFC 894(IP over Ethernet)
  - RFC 2674 (Q-MIB)
  - RFC 2030 (Simple NTP)
  - RFC 1213 (MIB-II)
  - RFC 1157 (SNMP)
  - RFC 2570 (SNMPv3)
  - RFC 2571 (SNMP Frameworks)
  - RFC 2572 (SNMP Message Processing)
  - RFV 2573 (SNMPv3 Applications)

- RFC 2574 (SNMPv3 USM)
- RFC 2574 (SNMPv3 VACM)
- RFC 2576 (SNMPv3)
- RFC 1945(HTTP V1.0)

Optional

- RFC2133 (IPv6-Basic.Sockets)
- RFC2292(IPv6-Adv. Sockets)

27.2.11 Bit operation Execution time

Processor (CPU) Bit execution time shall not exceed 0.1 micro seconds.

27.2.12 Modular Design

A Modular design shall be used to ensure that all power, controller, I/O and other modules can be individually changed without severely impacting the overall functionality of the PLCs.

27.2.13 Hot swappable

All PLC modules shall be hot swappable, without the need for removing power from or affecting the operation of the PLC.

27.2.14 Memory Backup

All data and program memory including symbols and comments shall be stored on non-volatile memory. No backup battery shall be used to maintain this memory.

27.2.15 Symbol Storage

The storage of the complete project data including symbols and comments on the CPU simplifies service and maintenance calls.

27.2.16 Spare parts availability guarantee from PLC Equipment Manufacturer

The Manufacturer of the PLC Hardware, Firmware and Software shall guarantee that Spare Parts/Replacement Parts shall be available for a period of not less than Seven Years or Eighty Four Months from the date of Acceptance of the PLC equipment. by Miami-Dade Transit.

27.2.17 Centralized maintenance

All configurations, software maintenance, diagnostics, alarm monitoring, and all other administrative actions that are to performed on any distributed or Centralized controller, shall be accomplished over the Ethernet Network.

28. IP Paging/Public Address System

28.1 Public Address System requirements

- Paging system shall be Network capable (Ethernet) and use an Ethernet network to initiate and complete all paging announcements.
- The User shall have the ability to select any single Station or group of Stations when making an announcement.
- The head end unit shall support a minimum of five low-level analog audio inputs.
- The Remote/Station systems shall produce a low-level analog audio output for use with existing Audio Paging Amplifiers.
- The system shall be capable of interfacing with a VoIP Telephone System.
- Multicast Protocol shall be supported
- Audio frequency response: 30 Hz to 15 Khz +/- 5 db.

29. VoIP Voice Telephony

- Provide VioIP Telephone Equipment that shall be compatible with the VoIP Phone System that is to be installed at the Airport MIC station.
- Each Station shall require support for a maximum of twenty-four Analog (POTS) telephones
- Technical Details will be provided when the MIC System details are known.

30. Ethernet Network Requirements:

The following equipment as defined by equipment table 3 shall be installed to support an Ethernet Network presence at all locations: The listed equipment or its approved equal shall be used.

All post acceptance configurations and programming shall be the responsibility of Miami-Dade Transit.

Mover Station Train Control Rooms			**Note: Dupont no Platform, Mover Maint. 3750**
Qty	**Mfg.**	**Part**	**Description**
21	Cisco	IE-3000-8TC	8 Ethernet 10/100 ports and 2 dual-purpose uplinks (each dual-purpose uplink port has 1 10/100/1000 Ethernet port and 1 SFP-based Gigabit Ethernet port, 1 port active)
21	Cisco	IEM-3000-8FM	Expansion Module with 8 100FX Ports
21	Cisco	PWR-IE3000-AC	Expansion power module for Cisco IE-3000-8TC
21	Cisco	CF-IE3000	Compact Flash Card
42	Cisco	GLC-LX-SM-RGD	Gigabit Ethernet SFP, LC connector, LH (1Gbps single mode) transceiver
Mover Station - Platform Level			
20	Cisco	IE-3000-8TC-E	8 Ethernet 10/100 ports and 2 dual-purpose uplinks (each dual-purpose uplink port has 1 10/100/1000 Ethernet port and 1 SFP-based Gigabit Ethernet port, 1 port active) w/ IP Services Image
20	Cisco	IEM-3000-8FM	Expansion Module with 8 100FX Ports
20	Cisco	CF-IE3000	Compact Flash Card
20			NEMA-4X Enclosures, with Hasp for padlock made from 304 SS used to house Switch and AC Power at Platform Level
20			Fiber, Power and Conduit to Platform Level from Train Control Switch
Station Spares			
2	Cisco	IE-3000-8TC-E	8 Ethernet 10/100 ports and 2 dual-purpose uplinks (each dual-purpose uplink port has 1 10/100/1000 Ethernet port and 1 SFP-based Gigabit Ethernet port, 1 port active) w/ IP Services Image
2	Cisco	IEM-3000-8FM	Expansion Module with 8 100FX Ports
2	Cisco	PWR-IE3000-AC	Expansion power module for Cisco IE-3000-8TC
5	Cisco	PWR-IE3000-CNCT	IE 3000 Power Spare Connector
Mover Maintenance Building			

2	Cisco	WS-C3750G-48PS	48 Port 10/100/1000 with PoE and 4 SFP supporting 32-Gbps stacking and IP Services Image
2	Cisco	GLC-LH-SM	GE SFP, LC Connector, LH transciever - non-rugged
Government Center			
		Spcc 4th Floor Train Control	
1		4507 chasis	
2		WS-X45-Sup6L-e	Cisco Catalyst 4500 E Serries Supervisor 6L-# 2x10GE (X2)
48		GLC-LH-SM	Gigabit Ethernet SFP, LC connector, LX/LH Transceiver
2		WS-X4624-SFP-E	24-Port GE SFP Card
		S45EIPBK9-12252SG	CAT4500E IOS IP BASE SH
2		XENPAK-10GB-LR+	10GBASE-LR , 1310nm Singlemode Optics
			Will need to have new Power and Rack installed.
		For 6500 for Interconnect of 4500 Switch	
2		WS-X6708-10G-3C	The 8-port 10 Gigabit Ethernet module (Figure 2) provides up to 66 10 Gigabit Ethernet ports in a single Cisco Catalyst 6500 chassis and 132 10 Gigabit Ethernet ports in a VSS. It supports 64 Gbps of local switching, ideal for deployment in the core or aggregation layer of LAN campus and data centers. All 8 ports can be used to create a virtual switch link in a VSS
2		XENPAK-10GB-LR+	10GBASE-LR , 1310nm Singlemode Optics

Table 3 – Ethernet Network Equipment requirements

31. Acronyms

PLC	Programmable Logic Controller	
DTS	Data Transmission System	Comprised of the PLC, I/O control and Fiber Optic Cable and associated equipment
VAC	Volts AC	60 Hz Alternating Voltage / Current
OSP	Outside Plant	Cable that is designed to be used outdoors where it is likely to be subjected to the elements of weather
UL	Underwriters Laboratories	An independent product safety certification organization
LC	Developed by Lucent	A small form-factor fiber connector that uses a push-pull latching mechanism and has a 1.25mm diameter ferrule. It is a high performance connector especially designed for single mode applications.
EIA	Electronic Industries Alliance	A trade organization composed as an alliance of trade associations for electronics manufacturers in the United States
TIA	Telecommunications Industry Association	A global trade association headquartered in the United States that represents about 600 telecommunications companies
NFPA	National Fire Protection Association	An organization that creates and maintains minimum standards and requirements for fire prevention and suppression activities, training, and equipment, as well as other life-safety codes and standards.
ANSI	American National Standards Institut	A private non-profit organization that oversees the development of voluntary consensus standards for products, services, processes, systems, and personnel in the United States
ICEA	Insulated Cable Engineers Associatio	Produce technical standards for the manufacture and use of power, data, and control cable.
ISO	International Organization for Standardization	An international-standard-setting body composed of representatives from various national standards organizations
IEC	International Electrotechnical Commission	An international standards organization dealing with electrical, electronic and related technologies
RoHS	Restriction of Hazardous Substances	Restriction of the use of hazardous substances in electrical and electronic equipment.
FOTP	Fiber Optic Test Procedure	
OTDR	Optical Time-Domain Reflectometer	An optoelectronic instrument used to characterize an optic fiber
PC-A	A Programmable Controller	Refer to PLC
PC-B	B Programmable Controller	Refer to PLC
VoIP	Voice over IP	A family of transmission technologies for delivery of voice communications over IP networks or other packet-switched networks.
SPCC	Stephen P. Clark Center	Building that houses County Agencies including Transit and Metro Mover Central Control.

AWG	American Wire Gauge	Used to define the diameters of round, solid, nonferrous, electrically conducting wire
IP	Internet Protocol	The primary protocol in the Internet Layer of the Internet Protocol Suite and has the task of delivering data packets from the source host to the destination host based on their addresses.
ICMP	Internet Control Message Protocol	One of the core protocols of the Internet Protocol Suite. It is used by networked computers' operating systems to send error messages
TCP	Transmission Control Protocol	One of the core protocols of the Internet Protocol Suite that provides a reliable and ordered delivery of a stream of bytes from an application on one computer to an application on another computer.
TFTP	Trivial File Transfer Protocol	A simple protocol to transfer files. It is designed to be small and easy to implement
ARP	Address Resolution Protocol	A computer networking protocol for determining a network host's link layer or hardware address when only its Internet Layer (IP) or Network Layer address is known
UDP	User Datagram Protocol	Used by applications to send datagrams to other hosts on an IP network without requiring prior communications to set up special transmission channels or data paths
TELNET		Provides bidirectional interactive text-oriented communications via a virtual terminal connection.
BOOTP	Bootstrap Protocol	A network protocol used by a network client to obtain an IP address from a configuration server
IGMP	Internet Group Management Protoco	A communications protocol used to manage the membership of Internet Protocol multicast groups
Q-MIB		
NTP	Network Time Protocol	A protocol for synchronizing the clocks of computer systems over packet-switched, variable-latency data networks.
MIB-II		
SNMP	Simple Network Management Protoc	A UDP-based network protocol. It is used mostly in network management systems to monitor network-attached devices for conditions that warrant administrative attention
HTTP	Hypertext Transfer Protocol	An application Layer protocol for distributed, collaborative, request-response client-server computing